TROPICAL AGRICULTURE

THE OFFICIAL JOURNAL OF THE IMPERIAL COLLEGE OF TROPICAL AGRICULTURE

VOL. I NO. 7. TRINIDAD, JULY, 1924. PRICE 6d.

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TROPICAL AGRICULTURE is published at the Imperial College of Tropical Agriculture, St. Augustine, Trinidad, West Indies, at the end of the third week of the month preceding the one of issue. Advertisement rates can be obtained at the College from the Editor, or from the Secretary of the College, 14, Trinity Square, London, E.C., England. The Editor will be glad to consider authoritative articles for publication. Correspondence is invited on all matters pertaining to tropical agriculture, science and development, which will be replied to.

RESEARCH WITH EDUCATION.

A policy, dictated to some extent by circumstances, is leading to the occasional publication of original work in this journal which, as its title implies, might be expected to confine its contents largely to agricultural news and technical articles of primary interest to the planter, technical manager and administrator. It must be conceded, however, that there is a good deal to be said for the initial publication of original research in journals such as this which circulate amongst general workers as well as amongst specialists, provided space permits, and the information is presented in such a form that as well as affording adequate scientific evidence for the conclusions arrived at it gives the information in an interesting and attractive manner. This is not a new idea. For some years this policy has been adopted to a limited extent in the "Agricultural Journal of India." Normally, of course, in accordance with orthodox procedure, a paper dealing with scientific research is not published in a journal of agriculture; a paper on soil physics such as that by Professor Hardy in the present number, might appear in a much more condensed, statistical and technical form in some recognised scientific journal published by a specialised central institution or society in England and America. Subsequently, if such a paper contained facts or ideas likely to interest the general reader in the field of tropical agriculture, such facts and ideas would be abstracted (often indifferently well) by another writer, and issued in a more general publication. Naturally, the publication of research in the academic manner is generally the means of conferring greater academic prestige on the writer, and it generally means that to follow any other procedure involves a degree of professional unselfishness. It is very necessary, therefore, to ensure that the course of publishing for the first time, original results in a generalised journal has a measure of real justification. It would seem that the justification lies, especially in agriculture, in the value of the procedure educationally. There is not the slightest doubt that the modern tendency in the direction of tropical agricultural research and administration is becoming weighted, with the neglect of agricultural education as a thing of equal standing. Scores of scientific papers find their way almost straight into library or laboratory files which could first with advantage pass before a wider public in a suitable form created by the author. But it is seldom done and one reason is that the conduct of research for motives of personal kudos or for Doctors' degrees without the wider consideration of public uplift and education is not uncommon. In tropical agriculture we have to-day, in many countries, far more knowledge than we are capable of applying. There would be a greater likelihood of this knowledge being understood and applied if original workers could put forward their results, particularly those which are of a far-reaching character, with that inspiration which only they can feel and with that human understanding and emphasis on principles, definitions, and notions which are too commonly regarded by the scientific purist as superfluous padding. Of course there are inefficiencies involved in this policy, and it must also be noted that it is not every scientific paper that will stand much popular treatment nor is every research worker capable of making it of educational value when it will. But in presenting scientific results pertaining to agriculture it always seems to us important to realise the artificiality of subject boundaries. Plant physiology, for example, embraces physics, biology and bio-chemistry, while the articles on estate accountancy in this journal will show how

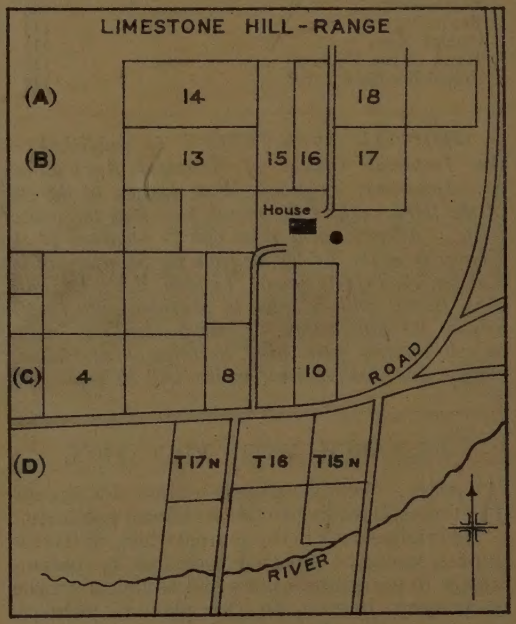
necessary it is to blend chemical and biological facts with economics. It follows that any really good and far-reaching scientific paper connected with agriculture should be capable of being presented in a form showing its connection with estate or industrial activities and prove of interest and of value to everyone concerned. It is common knowledge that great Departments of Agriculture, like that of the United States, disseminate their researches and instruction in several entirely separate and different forms of bulletins, and while this has a great deal to be said for it on the grounds of efficiency, convenience and economy of distribution, it is felt that the attempt which is being made in "Tropical Agriculture" to bring together the specialist and the practical planter on the same page may prove to be a policy of considerable educational value and one which will make itself usefully felt if continued and intelligently recognised.

FIELD MEASUREMENT OF SOIL MOISTURE.

PROFESSOR F. HARDY, M.A.

Introduction: The Water-supplying Power of the Soil.—One of the chief difficulties in the study of the effect of the environment on the growth of cultivated plants has been to trace the exact relationship between soil moisture and crop yield. Clearly, rainfall data alone cannot afford a reliable measure of the amount of water that is available for plant growth in any particular region, because drainage and evaporation remove a variable quantity of water which can never become accessible to roots. Nor can determinations of the gross moisture content of the soil furnish precise measurements of available moisture, because different types of soil hold water with different degrees of tenacity, and it is impossible for the plant ever entirely to deplete a soil of its moisture. Especially is this so in clay soils containing colloidal matter. Soil colloids, because of their peculiar fine sponge-like structure, are able to store up large amounts of water, and compete with plant roots for its possession. When fully saturated, a large fraction of their moisture content may be abstracted relatively easily by plants, but the supply becomes more difficult to maintain as depletion progresses. Given a constant reserve of moisture, the *rate* at which plant roots may draw upon the store depends largely on the ease with which water can be transferred from one part of the soil to another, and this, in turn, depends on the permeability of the soil as decided mainly by texture. All that the plant desires, so to speak, is a large reservoir of water which can easily be drawn upon, as required, through channels of low resistance. Increase in either or both of these conditions will lead to a greater water supply for the plant. Hence we get the conception of water-supplying power as an intrinsic soil factor composed of two main sub-factors, namely storage capacity and permeability, which themselves are decided by many other minor factors.

Soil Point Method.—In 1920, Dr. Livingston, of John Hopkins University, measured directly the water-supplying power of a soil by employing a kind of "artificial root." Actually, porous porcelain cones (soil points) of uniform dimensions were used. The gain in weight of one or more of these soil points, when pushed into the soil and allowed to remain there for a definite period of time, was taken as a measure of its water-supplying power. The method was further developed (1921) by Dr. Mason, formerly Professor of Botany at the Imperial College of Tropical Agriculture, who employed ordinary hard graphite writing pencils as soil points. By taking a sufficiently large number of pencils, preferably in pairs, results were obtained which, treated statistically, could be relied upon accurately to measure water-supplying power. Recently the writer has applied Mason's method to actual field problems. The details of procedure have



ROUGH SKETCH MAP OF CASSADA GARDEN ESTATE

already been described* and need not be restated, but so far, no data relating to the field applications of the method have been published. The following results may therefore be of interest to planters and to others concerned with soil problems. They refer to observations made on Cassada Garden sugar estate in the West Indian Island of Antigua, and are presented with the kind permission of the manager, Mr. S. B. Smith. It should be realised, however, that the method is of universal application, and can be applied to all soils irrespective of whether the crop is sugar-cane, cacao, rubber, cotton, &c.

Characteristics of Area Studied.—The area studied comprises about 230 acres of land bordering

* *Journal of Agricultural Science*, Vol. XIII, 1923, p. 355.

a low limestone hill range, and sloping gently in a southerly direction. The soil is a heavy clay, which is comparatively uniform as regards its

TABLE I.—PHYSICAL CONSTANTS OF THE SOILS EXAMINED.

1	2	3	4	5	6
Section and field number.	% $CaCO_3$	*Maximum water-retaining capacity.*	*Water required to saturate the soil colloidal matter.*	*Relative permeability to water.*	*Relative cohesiveness (Inverse of friability)*
	Percentage on oven dried soil.				
A 14	23·8	83·1	43·6	24·0	8·2
A 18	14·4	84·9	45·4	69·0	—
B 13	10·0	85·2	45·4	24·0	—
B 15 + 16	6·9	85·5	46·0	7·0	—
B 17	6·1	86·3	46·6	10·0	12·9
C 4	2·3	85·0	45·6	9·0	—
C 8	2·9	82·3	42·8	7·3	20·2
C 10	3·0	79·6	40·1	12·2	—
D T17 N	1·2	84·7	45·2	12·0	—
D T16	1·5	88·6	49·1	8·2	30·2
D T15 N	2·5	83·2	45·2	6·5	27·1

content of colloidal matter over the whole area. The content of calcium carbonate varies rapidly, however, from about 20 per cent. in the fields adjacent to the hills, to about 1 per cent. in the fields forming the southern boundary of the area, which is distant about one-half of a mile from the hills. In consequence, the permeability of the soil is much superior in the northernmost fields. The fields have received similar manurial treatment and are continuously under sugar-cane (plant canes, first ratoons and second ratoons), with the exception of a fallow crop every fourth year.

The Problem.—The sugar-cane crop in Antigua suffers annually from drought. It has been noticed, however, that the canes in certain fields suffer less than those in others, even though culturally treated in identical manner. The difference has been assigned by the manager of Cassada Garden for the fields under his charge to be due mainly to differences in calcium carbonate content of the soils. Those fields that consist of soil rich in lime appear to suffer less from drought than do those poor in this substance. In order to test the point, the writer undertook a laboratory examination of representative samples of the soils, together with a field study of their water-supplying powers.

The Results.—The data in Table I indicate, the chief physical characters of the soils, and the diagram explains the relative positions of the fields. The figures in columns 3 and 4 of Table I show that the soils of the different fields are very similar as regards their ability to store water. They possess almost equal water-retaining capacities, and contain approximately identical amounts of colloidal matter. The figures in column 5, on the other hand, show that the soils vary progressively in permeability when traced from north to south. This is evidently due to differences in calcium carbonate content, which has rendered the northern soils less cohesive and more friable in proportion to the amount of lime present. We should therefore expect, according to our theoretical conclusions, that the water-supplying power of the soil would be greater at any one instant in the more calcareous soils of the northern part of the estate. The data in Table II amply confirm this. In columns 3 and 4 of this table are recorded two sets of determi-

TABLE II.—WATER-SUPPLYING POWERS OF THE SOILS EXAMINED.

1	2	3	4	5	6	7
Section and field number.	% $CaCO_3$	*Water-supplying power.*		*Total moisture content of soil, April, 1922.*	*Crop yield. Tonnage of cane, including plant canes and 1st and 2nd ratoons.*	
		Determined May 28, to June 8, 1921.	*Determined April 25 to April 27, 1922.*		1918-20	1919-22.
A 14	23·8	2·96	—	—	—	—
A 18	14·4	2·74	3·97	40·5	41·8	—
B 13	10·0	2·39	—	—	34·7	—
B 15 + 16	6·9	—	—	—	—	52·0
B 17	6·1	2·71	3·63	37·9	44·9	—
C 4	2·3	(3·40)*	3·02	32·6	—	37·0
C 8	2·9	2·28	3·16	37·1	—	37·5
C 10	3·0	(3·45)*	—	—	37·2	—
D T17N	1·2	—	—	—	—	—
D T 16	1·5	2·70	2·53	40·1	—	—
D T15N	2·5	2·32	2·82	36·2	—	—

nations of water-supplying power. These were made at the ends of the dry seasons of 1921 and 1922 respectively. In Antigua, the dry season extends from February to June. During these five months usually only about one-seventh to one-fifth of the total annual rain is precipitated, and this is distributed in light showers that do little more than wet the growing plants, or moisten the trash that is spread over the soil to protect it from excessive evaporation. Thus, in 1921 the total rainfall was 33·1 inches, of which only 4·9 inches fell during the dry season. In 1922, it was 36·4 inches, with 8·3 inches for the dry months. Since the area under consideration is small, it may be assumed that the total rain falling on

* The high magnitude of these values is accounted for by temporary bad drainage in these fields.

each acre of land is the same in amount, and since cultural treatment is uniform, it may be further assumed that a constant fraction of this total rain gets into the soil, with the reservation that the southernmost fields probably obtain more moisture because the land slopes in their direction. Nevertheless in spite of this, the figures for water-supplying power show that the northernmost soils under the almost stable conditions enforced by prolonged drought, are able to supply moisture to plant roots at a greater rate than the southernmost soils, which fact must be assigned to the effect of lime in conferring on them a greater degree of permeability. It should be noted that the higher figures for 1922 may be explained as due to the less rigorous drought of that year. The figures in column 5 indicate the actual differences in *gross* soil moisture content for certain of the fields at the time when the second set of water-supplying power determinations were made. They show no direct relationship with these figures, as may well be expected from the preliminary discussion.

Relation of Crop Yield to Water-supplying Power of Soil.—An attempt has been made in columns 6 and 7 of Table II to compare crop yields of different fields with water-supplying powers. The nature of the crop renders strict comparison difficult. The complete cane crop consists of three generations, namely, plant canes, first ratoons and second ratoons, and occupies the land for three whole years. Different fields are planted up in different years, so that, on the average, and allowing for the fallow, only one-fourth of the total number of fields of the estate is planted afresh in any one year. Furthermore, the same variety of cane plant need not necessarily be employed for planting each field. Lastly, certain fields are ratooned only once instead of twice. Because of these restrictions, it has been found possible to compile only a limited number of relevant data. The figures in column 6 refer to the crop that was planted with a certain variety of cane in 1918, and ratooned in 1919 and 1920. The figures in column 7 are not so satisfying, since they start with a second ratoon crop and include a fallow. The conclusion may be drawn, however, that crop yields show fair positive correlation with water-supplying power of soil. The conclusion is considerably strengthened by the fact that the order of productivity, as set down by the manager on evidence given by actual crop yields for many years, and by general experience, coincides quite closely with the order of water-supplying power of the soil of the several fields examined.

Indications of Desiccation.—One other interesting observation can be made in connection with the results of the field moisture studies. The figures for water-supplying power at the end of the dry season of 1921 are of especial significance because that year was one of almost unprecedented drought. They therefore indicate the lower limit to which the condition may be expected to attain. The water-supplying power of the soil near the point of permanent wilting of the sugar cane plant was found in the writer's previous investigation to be 1·71, which should be compared with the lowest figure recorded in Table II, namely 2·32. Evidently the cane plants were still safe from desiccation, although considerable anxiety was felt for their future.

Possible Application of the Soil Point Method.—The above account of the use of the soil point method in a physiological study of soil moisture emphasizes the fact that we here possess a means of studying many soil problems that so far have received only limited investigation. For example the effect of different sorts of mulches in conserving soil moisture may be more accurately studied by its aid. Also the effect of various manurial treatments on the water relations of soils might be re-examined with greater precision than heretofore. Further, the differences that various crop plants exhibit as regards their water requirements at different stages of growth, and the response which the soil shows to these demands may be demonstrated by the use of soil points. The method may also be applied to studies of the distribution of plants in different natural habitats, and to the problem of root distribution in relation to soil conditions. Finally, the planter should be enabled by its aid to obtain much more precise knowledge of the physical environment of his crops, and to correlate this with rainfall and with certain soil moisture constants for the particular area of land that interests him. The method, however, in spite of its remarkable simplicity, can be expected to yield reliable results only when used by investigators who have had some training in precise quantitative experimentation.

THE COTTON OUTLOOK.—As improvement in the English cotton trade next year depends very largely on the extent and price of the crop that is now growing in the American cotton belt, the International Federation of Cotton Spinners proposed sending a deputation to the United States in July, with the object of obtaining accurate information from the growers. In recent years the reports that have been issued from American sources, including those that have had upon them the official stamp of Washington, have been misleading and increased the difficulties of a business which grows more intricate and more risky every year. The recent report of the British Cotton Growing Association draws attention to the significant fact that American mills in the last twenty years have increased their consumption of American-grown cotton from 36 per cent. to 61 per cent. If that process should continue for another twenty years America will have no cotton to spare for Europe. This fact, alone, demonstrates the essential necessity of the British Empire cotton-growing movement, the success of which is now well assured in view of the recent progress made in Africa and Australia.

RATOON COTTON.

PROFESSOR S. C. HARLAND, D.Sc. (Lond.).

According to the April number of the "Empire Cotton Growing Review" the Cotton Industry Act of Queensland, 1923, contains a provision that no ratoon cotton plants shall be grown. Around this provision much controversy has raged, and according to recent numbers of the "Cotton Farmer," a periodical published in Queensland many farmers are of opinion that the case against ratoon cotton is insufficiently strong to justify the total prohibition. It is argued on one side that the quality of ratoon cotton is bad being weak, irregular and neppy, while on the other hand it is maintained that ratoon cotton has a market, that it will sell, and that it is uneconomical to replant each year, particularly when it is borne in mind that labour costs in Queensland are high. The question of insect pests is also brought into the discussion: the anti-ratooners state that it is dangerous to grow ratoon cotton on account of the rapid increase of insect pests which result from this practice while those in favour of ratooning are confident that there is no insect pest of any importance whose spread will be favoured if ratooning is permitted.

It is no part of the present writer's task to pronounce any definite opinion for or against ratooning so far as Queensland is concerned, but since an adequate analysis from the botanical point of view has never been put forward, it seems advisable to provide such an analysis so far as present knowledge permits.

We may conveniently begin by describing the habit of Upland cotton when grown in frostless reigons, *i.e.* in or near the tropics. The main axis of the plant, consists typically of a vegetative zone, and a reproductive zone. Each node of the vegetative zone, comprising the first five or six nodes above the cotyledons, is capable of giving rise to vegetative branches called monopodia, which are similar in morphological structure to the main axis. In the reproductive zone each leaf has at its base two buds, an axillary bud and adjacent to it an extra axillary bud. The extra axillary buds grow out into fruiting branches or sympodia, which are somewhat zig-zag in appearance and bear bolls at each node, opposite to a leaf. The axillary buds in the vegetative zone may either produce vegetative branches, short fruiting branches, or remain dormant. In field crop from fifteen to thirty or more fruiting branches are borne on the main axis and if conditions are favourable for the growth of vegetative branches from the lower nodes, each of the branches may, after five or six nodes produce fruiting branches. When the bolls have ripened in one season growth, the plants may be cut down almost to the ground, and the dormant buds of the vegetative zone will produce fresh monopodia whose subsequent history is essentially the same as that of the primitive main axis. The rapidity with which the new set of monopodia produce fruiting branches depends chiefly on the number of nodes to the first fruiting branch of the initial main axis. If the vegetative zone of the latter comprised only a few nodes, the vegetative zones of all the secondary branches will behave similarly, and under conditions which favour vegetative activity there may be practically no rest period at all, and the plants will be in a continuous reproductive phase. This type of behaviour is the one met with in St. Vincent, and is induced by heavy rainfall and comparatively high humidity. It may be said definitely that where environmental conditions favour continuous fruiting with little or no rest period, not only will insect pests and fungoid diseases be unduly favoured, but that the quality of the cotton will be inferior. The reason for the inferiority may be discussed.

Good cotton is characterised by (*a*) uniformity in length, (*b*) uniformity in cell wall thickness, and good cotton can only be produced if the lint hairs experience good nutritive conditions throughout their life history. This implies principally an adequate leaf surface to provide for the necessary synthesis of carbohydrates which go to form cellulose. Cotton produced at the end of the season, when most of the leaves have dropped off, and vegetative vigour is feeble, will be characterised by thin cell walls and irregularity in length, and according to the writer's experience ratoon Upland plants seldom have the vegetative vigour necessary to ensure good thickening of the lint hairs. In regard to Upland plants grown in the Tropics it must be concluded that only under exceptional conditions will the quality of the ratoon cotton be up to the standard required by the spinner from good grades of American cotton.

It must not be forgotten, however, that a great deal of ratoon cotton is grown in the Tropics, particularly in Brazil, and in the Grenadines of the West Indies, ratoon cotton has been grown for a hundred years or more of such quality that it brings a better price than Upland. Microscopic examination of the second and third year plants shows that the quality of the staple is no worse, and indeed is often better than that produced in the first year. It is clear then that the quality of ratoon cotton depends on the breed of cotton grown and that bad quality is not a necessary corollary of ratooning.

A short summary of the difference in habit between a West Indian cotton which tolerates ratooning with no deterioration of quality, and Upland cotton may be given at this point. First the vegetative zone of a West Indian native, or Marie Galante cotton comprises a great number of nodes, 25 to 35, and similarly all the vegetative branches springing from this zone have to produce a long vegetative zone before they can bear fruiting branches. Thus, when the plant is cut back at the end of the season there is a long vegetative season from the beginning of April or May to November, during which the plants are producing monopodia with 20 or more nodes.

By November the vegetative zones have been completed and the plants then produce fruiting branches on a plant body which has an active leaf surface, and is fully capable of providing the necessary nourishment for full thickening of the lint hairs. To sum up, deterioration of quality in ratoon cotton can only be avoided by providing a type of plant the vegetative vigour of which is provided for by extensive vegetative zones, *i.e.* by growing monopodial or perennial types.

In point of fact it is possible to combine the monopodial, habit with lint of practically any desired quality ranging from Sea Island downwards by hybridising perennial types among themselves. The question of what type of cotton to grow in the tropics has usually been settled by assuming that the annual Upland cotton is the only one possible, but it is probable that some type which can be ratooned will ultimately supplant Upland. The present writer is of opinion that the vast reservoir of types provided by the present New World perennial cottons will need to be explored by the plant breeder before the final decision can be made.

As to yield this will depend chiefly upon the density of the plant population (spacing). The yield of ratoon plants is not necessarily lower than that of first year plants and is often greater.

A final reference may be made to the entomological aspect of the situation. Each tropical cotton growing country will have to decide whether insect pest exists in it which prevents the growth of perennial cotton. So far as the West Indies is concerned Leaf Blister mite effectually prevents the ratooning of Sea Island cotton, but the perennial types are immune to this pest. Neither Pink Boll worm nor cotton stainers are to be feared if the necessary cleaning up is given to the fields at the end of the season.

The statistics appended to the report of the British Cotton Growers' Association for last year show that the Uganda production of 85,000 bales of 400 lb. has out-distanced that of all previous years, and is more than twice as much as in the previous year. Tanganyika territory with 10,100 bales, has also doubled its previous year's figures, and the total for East, Central, and South Africa, including Kenya Colony, Nyasaland, and Rhodesia and the whole of the Union territory, was 108,800 bales, against 54,200 bales in 1922. Northern Nigeria also had a good season, with "record" figures of 13,900 bales, but the southern provinces were again backward. The Sudan production (28,000 bales) is a "record" figure.

The approximate value of the British Empire grown cotton crop was £5,503,000, against £2,716,000 in the previous year. This figure of value has been exceeded only in the year of boom prices, 1919—for less than half last year's total British production of 178,200 bales.

TEA IN THE WEST INDIES.

[*Mrs. S. F. Ashby has recently furnished us with information obtained from friends regarding the interesting commercial experiment with tea in Jamaica. Acknowledgment is also due to the late Hon. H. E. Cox, the entrepreneur, for certain facts put forward at the Imperial Agricultural Conference held in Jamaica in* 1907.]

The tea plant, exceptionally remarkable botanically, is also of great historical interest on account of its relationships with man. Mentioned by Confucius and later taxed in China whence it spread to Japan, tea-drinking had for centuries been confined to the Far East and it was only in the seventeenth century that tea found its way to Java and to Europe and was discovered as an indigenous plant in the lower Himalayas of India by Captain Bruce. The commercial story of the British East India Company during the middle century of its operations is largely the story of the tea trade. Out of it arose the great number of limited liability companies now operative in India and Ceylon with a combined capital of something like £20,000,000 and affording employment to over two million natives and an income to countless shareholders in Europe and America. The industry like the rubber industry, has never developed in the New World for very similar reasons to those given under the title of A Trinidad Rubber Estate in this Journal for May. Tea, in respect of quality needs a sub-tropical climate; in respect of yield constant moisture is an essential. Tea-culture also makes great demands upon labour and can only be grown economically where there are large numbers of women and children working at an economic rate of remuneration.

The enterprise in Jamaica, initiated about 1900 was largely in the nature of an experiment. But it was a properly conducted experiment and has proved itself a success. The Blue Mountains with their high elevation of 4,000 to 5,000 feet might be expected to have formed the best locality for tea, but the demands on labour made it necessary to start the first plantation at a lower level (1,600 feet). Yet the plants and seeds were obtained from "Cinchona," the Government Station 5,000 feet in the Blue Mountains, and the entrepreneur of the experiment—the late Mr. Cox—was wise enough to recruit an overseer from Ceylon which no doubt had something to do with the success achieved. At first the tea was dried and rolled by hand; later, however, it became necessary to import machinery for purposes of economy.

The estate in question has about 250 acres planted in tea and a rainfall of about 83 inches per annum with 200 rainy days out of the 365. The tea was first placed on the market in 1903 and proved to be of good quality for blending. In recent years labour costs have risen and this has led to a certain amount of deterioration of the plantation. Labour at present is about 9*d.* to 2*s.* per day, children and women 1*s.*, men 1*s.* 6*d.*

to 2s. Tea is paid for on this estate by the basket when it is weighed at the factory. It is generally held that every acre of tea needs the labour of one man per annum. Even in Louisiana, with an expensive crop like sugar-cane, the labour of one man for one month is all that is needed, yet this is regarded as very exacting as tropical crops go. The point illustrated by these facts is the extremely expensive nature of tea culture in respect of human labour and attention. Only in the most exceptional circumstances can tea prove a commercial success in the West Indies unless the cost of production should show a general increase in the East. That, however, would be passed on to the consumer and very quickly the quantity consumed by the world would decrease. The ultimate future of tea, considering conditions in India to-day is one that gives cause for reflection if not for anxiety. As with other products of this kind quality is the telling factor in competition and is one of the matters being given attention at the Imperial College of Tropical Agriculture where samples are being imported for training in tasting and where a small tea plantation near the northern hills of Trinidad is likely to be established for instructional purposes in respect of agronomic culture and technological processes of tea manufacture.

GEOGRAPHICAL NOTE.

New Guinea and British East Africa.—Confusion still exists, perhaps justifiably, in the minds of many people, in respect of the difference between New Guinea and Papua, and between Uganda, Kenya, Nyasaland and Tanganyika. Papua (formerly called British New Guinea) is composed of the southern portion of New Guinea—itself the largest island in the world, excluding Australia ,to the north-east of which it lies—and a number of adjacent islands. The total area of the Papuan part of NewG uinea is 90,540 square miles (New Guinea itself is 234,768 square miles). The "Territory of New Guinea" (formerly German New Guinea) is the north-eastern part of the island of New Guinea and has an area of about 70,000 square miles. Papua is a possession of the Commonwealth of Australia ; The "Territory of New Guinea" is under Australian mandate. The remaining region of the island of New Guinea is a Dutch possession. Uganda, Kenya, Nyasaland and Tanganyika are British East African Protectorates extending more or less in the order named, from the southern Sudanese and Abyssinian borders on the north down to those of Northern Rhodesia and Portuguese East Africa on the south. The area of Uganda is estimated at 110,300 square miles including 16,377 square miles of water (Lake Victoria Nyanza); the area of Kenya which consists of a Colony and Protectorate, is 248,800 square miles, and was formerly known as the East African Protectorate (geographically it is part of Uganda but is politically except for Kenya connected with Zanzibar). Nyasaland is a Protectorate lying on the western side of Lake Nyassa and is therefore essentially an island territory—its total area is 39,956 square miles. Tanganyika is mandated German territory lying to the south of Kenya and Nyasaland and has an area of about 373,000 square miles. The above definitions are intended to be only approximate. The reader should refer to a *recent* large-scale map of Africa for more exact information.

Industrial Education.—One of the greatest uses of education in industry is to increase the interest of staff and of manual workers in their work. There are various ways of doing this, but it is certain that the only true way is to enlighten them as to the place which their detailed work takes in the finished product or results. Several methods have come into use under factory conditions in northern countries, the most successful method, for getting quick results, being the diagram system in which the competed product is shown in drawings of black and white, each copy containing the particular portion made in a certain section as a coloured inset. This would not be difficult to apply under conditions of tropical agriculture in respect of chemical technology, while diagrammatic lectures of plant growth could also be given with a specialised economic setting to overseers, superintendents and to men of the contractor, or driver or foreman type. Diagrammatic accountancy and statistics would also help to enlighten these estate employés in the worl of the estate, but of course there is a limit to this in the tropics owing to the fundamentally low standard of intelligence usually obtaining amongst the masses. Nevertheless more could and should be done, for it is becoming increasingly necessary that labour should understand something of the fundamental facts of industry as a check against the many wrong and illusive ideas that are now being spread by agitators.

Mace is mostly used by manufacturers of sauces and pickles, although a small quantity is sold to the general public. Ground mace still enjoys a considerable sale. It is a valuable stimulant, carminative, and flavouring agent, but its use in excessive quantities must be guarded against, since it produces narcotic effects such as those resulting from the use of camphor. If ground mace is to be kept for any length of time, it is advisable to place it in a bottle or air-tight receptacle, as it will otherwise lose its strength very quickly. The wild mace, which is sometimes mixed with it, is practically valueless for which reason it is an offence against the adulteration laws to thus employ it.

The well-known liqueur Benedictine contains about 5 per cent. of mace, the other constituents being angelica root 30 parts, angelica seeds 20 per parts, cloves 5 parts, cinnamon bark 5 parts, balm herb 30 parts, and anica flowers 5 parts. Mace (which is derived from nutmegs) is mainly produced in the East and West Indies. The Moluccas are the historic homes of the spices.

TROPICAL WORLD.

GUATEMALA.

Energetic efforts are apparently being made to develop banana production on the southern and western coasts, that is on the Pacific side of this Republic. At the present time banana production is almost entirely confined to the Atlantic or north-eastern side where the United Fruit Company has one of its largest Central American Divisions. The new development is being pushed by the Government and local capitalists, and it is claimed by agriculturists that the fertility of the south-western lands is greater even than on the Atlantic side on account of the detritus from volcanic eruptions in the Cordilleras. The Atlantic banana lands are almost entirely alluvial in nature, and although the rainfall is higher in this region it is claimed that the soil retains moisture better in the south-west. Transport is the difficulty in the new region not only to the coast but also in regard to regular steamship facilities as well. It would appear that but little progress can be made in the new regions (except in regard to producing bananas for sale within the colony) until the steamship arrangements and general organization are satisfactory. The greatest locally-owned industry in Guatemala is coffee, but there are also one or two small central sugar factories and a good many cattle ranches as well. The Organo de la Associacion General Agricultores, in a recent announcement calls the attention of the public to the existence and work of the Imperial College of Tropical Agriculture, adding that the institution offers important facilities that should interest parents desirous of securing for their sons a sound agricultural education of a character both practical and comprehensive.

NORTHERN AUSTRALIA.

If these be days of descriptive travel rather than of local geographical analysis, many of the journeys accomplished, often under conditions of much hardship, provide inspiring and often valuable information. The journey of Mr. Michael Terry and Mr. Yockney in a second-hand Ford across the deserts of Northern Australia emphasizes the controlling influence of water-supply and communications in many regions of the tropics. Much of the country traversed by the travellers has been taken up by large pastoralists and every now and again the travellers came across a homestead. Across the Barclay Tableland the Government has sunk sub-Artesian bores at intervals of twenty miles, but the water does not rise to the surface but is pumped up by windmills. But for these watering places, says the "Field" the journey could never have been continued. The going was very rough across the Northern territory, and often the maximum rate of travel was no more than three or four miles an hour. Wherever there was water, bird life was plentiful and varied, but other animal life was very scarce. Between Camooweal and the Fitzroy river no kangaroos or emus were seen, but the howling of dingoes sometimes disturbed the night's rest, and Mr. Terry reports that the buffaloes introduced into the Northern territory have multiplied exceedingly. There is some talk of building a railway across part of this country.

THE NILE.

The Right Reverend Bishop Gresford Jones delivered a highly interesting lecture before the Royal Colonial Institute a month or two ago on his impressions of a journey from Egypt to Uganda. The distance travelled was 6,000 miles and the lecture dealt with three stages namely, through Egypt, through the Sudan, and through Uganda. That such a journey can nowadays be made to a large extent by modern railway and steamer travel is glowing testimony to the enterprise and skill of British engineering achievements in Africa, the importance of which we have never failed to emphasize in these notes. Only during one 5-day stage of the journey in the lower Sudan before reaching the Uganda boundary was it necessary for Bishop Gresford Jones and his companions to travel on foot. From the point of view of impressions, those having regard to the Sudan are of greatest interest: there are two Sudans: the Mohammedan Sudan of the north and the pagan Sudan of the south. The people in both are progressing. As the result of the British Empire cotton-growing movement, many parts of the country have been transformed during recent years, and from an economic point of view the lecture under consideration conveys a glowing tribute to cotton development both as a moral and physical benefit to the Sudan and Uganda. Transcending everything is the Nile itself, the greatest and most historic river in the world, not only as a means of transport but as a source of vital sustenance to the inhabitants.

CEYLON.

Continued attention is being given in the local press in support of research in the coconut industry, and it appears likely that special coconut experiment stations will be opened in the near future. Already, in Madras, four such stations are already at work. Among the problems being studied in Madras and needed in Ceylon are the relations between rapidity of germination and future vigour of growth, the best age to plant out seedlings and the suitability of different fertilisers. It appears that a study of the relation which the date of harvesting has on the yield of copra and oil goes to indicate that though December-January nuts are the smallest, they show the highest oil-content; while the April-May crop which yields the largest number and largest size of nuts, is, from the commercial point of view less valuable. Complaints continue to be published in Ceylon in regard to the exportation of rubbishy tea. The latest irregularity, or what really amounts to a scandal, is the announcement that a large London importing firm has discovered pieces of stone, brick, cement and most dangerous of all glass, in cases recently received. Most of

the glass has been in pieces large enough to be noticed, but it is more than probable that a great many small pieces have passed through the plantation machinery without being detected.

PAPUA.

Recent notices state that the Kiana-Tavai Estates, Ltd., are offering an attractive investment to those interested in cotton growing and the production of copra. The properties consist of about 2,390 acres of leasehold land with from 84 to 97 years to run. Much of this land is stated to be suitable for cotton, considerable quantities of this product as well as of sisal hemp having been already produced. Development appears to be going on also in regard to rice production. A rice mill with a 50 B.H.P. oil engine has recently been erected at Port Moresby and the latest rice cleaning machinery from America has been erected. Altogether it would appear that under the influence of Australia and the New Guinea Department of Agriculture considerable progress may be expected in this island during the next few years. Papua has an area of 90,540 square miles, a considerable aboriginal population as well as white inhabitants the latter numbering 1,134. (*See p.* 103.)

PONDICHERRY.

Captain H. G. Tranchell, His Britannic Majesty's Consul, Pondicherry, has sent us an interesting letter describing agricultural conditions in this territory, and containing expressions of his appreciation of the value of "Tropical Agriculture" to those living and working in foreign tropical countries. Pondicherry is in Madras and together with Chandernagore covers only 196 square miles with 275,000 people constituting the sole remaining French territories in British India. Pondicherry, the centre of the French and British antagonism in the eighteenth century for domination in India has naturally absorbing historical associations, and from the French point of view, at any rate, Pondicherry will always be associated with the name of Dupleix, Governor-General under the old French East India Company, and probably the most outstanding and brilliant personality in the whole history of French colonial expansion. With regard to present agricultural conditions, Captain Tranchell points out that though the French territory in Pondicherry is very small, it is closely cultivated. The land, which is mostly flat, is very fertile and irrigated by a system depending on a large natural tank, which situated among some low hills, forms a kind of catchment area. Naturally the abundance or otherwise of the monsoon rains which come with the north-east Monsoon from October to January has a great effect on the quantity of water available for irrigation. The drinking water of the town itself, states Captain Tranchell, is derived from some excellent wells whence it is pumped through a reservoir and flows through pipes to the town and houses. By far the greater amount of land under cultivation is given over to rice and other crops, that under the former being known as "wet lands" and that under other crops as "dry land." The dry land crops include millet, maize, and pulses. Other important crops are those producing oil seeds such as castor, sesame and ground nuts. Large tracts of the Province of South Arcot, in which the French territory of Pondicherry lies, are devoted to the cultivation of the ground nut and the export of decorticated ground nut seeds is the biggest item in the trade of Pondicherry. Captain Tranchell adds that at Nellikuppam in British territory, some twenty-five miles distant from the town of Pondicherry, there is a sugar factory of considerable size where both sugar and sweets are made from sugar-cane. This factory, says Captain Tranchell, has about 15,000 acres of cane land and also buys cane from native peasant growers. In a list of the areas under different crops in Pondicherry, it is noted that the largest areas are under millets, grains and pulses with rice second and oil-bearing plants third, the produce of the first two being used for local consumption. At the present time a small area is under cotton and indigo.

KENYA.

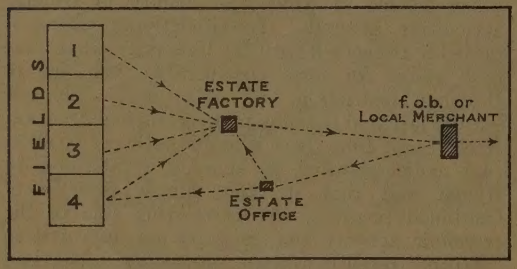
Coffee planting in many countries at the present time seems to have entered the category of those minor booms in which the history of tropical agriculture abounds. The underlying reason is probably connected with the high prices that have been ruling for some considerable time due to Brazilian restriction and unfavourable climatic seasons last year in many parts of tropical America. At the same time there is ample evidence to show that coffee-planting is soundly established in Kenya and that it offers much promise of continued progress. An interesting sign of the economic activity that is going on appeared in "Truth" recently when a proposition advertised by the Kenya Coffee Plantations Ltd., received comment and publicity. The offer was the semi-development plan of purchase whereby an estate might be acquired, guaranteed containing a certain proportion of coffee land and maize land, &c., the main development being done by the Company at an inclusive price. As an example of this, the list included an estate of 210 acres, comprising 50 acres of coffee land, 120 of arable, and the balance mixed land. The "eventual income" from this estate was put at £1,000 per annum, and the price was £2,000. Propositions of this kind would be the subject of much less unenthusiastic comment if sufficiently adequate and authoritative information were given. While development schemes continue to be largely in the hands of non-technical financiers there will always be an inordinate amount of feeling of uncertainty in regard to them on the part of small capitalists and critics. In connection with the geographical situation of Kenya the reader should refer to the note on page 103, but it should be remembered that both Kenya and the other Protectorates possess highland plateaux.

ESTATE ACCOUNTANCY.

PROFESSOR W. R. DUNLOP.

[*The following is the fourth article of this series and deals very briefly with the system of accounting known as cost-financial. Although the sample accounts and figures (as in most previous instances in these articles) have specific reference to coconut production, it is necessary for the reader to realise that the principles and methods apply equally to estates producing other kinds of produce. In preceding articles in this series, the administrative aspects of accountancy, balance sheets, methods of double-entry, valuation and depreciation have been dealt with.*]

Costs.—The term cost can be used in reference to the cost of an operation, the cost of equipment, the cost of a finished article (or unit) and the cost of that article (or unit) at different stages of its production. In practice, costs are mainly made use of either (1) for financial purposes, or (2) for statistical and regulatory purposes. An example of (2) is when the weekly abstract or analysis sheet shows the cost of a certain operation like weeding in a certain field, (*a*) this week, (*b*) this week last year, (*c*) estimate of this week, (*d*) cumulative cost to date. I propose in this article to deal with the cost-financial side, for the statistical



or regulatory costs can obviously be more conveniently and efficiently considered with what they belong to, namely, the keeping of routine records, which we agreed to work down to from general principles.

The Principle of Financial Costing.—In estate accountancy the principle of costing is of a character fundamentally dynamic. In regard to financial costing we have primarily to consider a producing estate during crop, the feature of which is a constant stream of produce passing outwards and of cash passing inwards (*see* Figure). Our principal object in determining costs for financial and administrative purposes is to arrive at the true cost of the produce at certain important points in its economic journey and to incorporate such costs with the estate assets. Generally speaking these cost points will lie :—(*a*) at the delivery of the untreated or semi-treated plant product at the estate factory ; (*b*) at the storage point ready for despatch, that is, after the product has been manufactured and packed ; and (*c*) at the selling point or point at which the estate's responsibility ends, usually f.o.b. nearest port.

Apportionment.—It will be evident that apart from labour each one of these different stages absorbs a different proportion of supervision expenses, live stock services (generally transport), depreciation, insurance, &c. Therefore we cannot arrive at the true cost at the different stages unless we can with reasonable accuracy debit the different stages with what it absorbs. In practice the most convenient method of overhead apportionment is generally on the basis of labour employed, more especially in regard to supervision.

Utilization.—We must be careful also in determining true financial costs, to take into account at what rate and to what extent expenditure actually goes into production after it is expended. The application of pen manure and nitrate of soda both involve current expenditure but if only half of the nitrate is absorbed during the financial year it is probable that the remaining half will be washed out of the soil : the whole is a charge against current expenditure. But in the case of pen manure there is a well-recognised residual and even cumulative value. In this case all the manure will not enter into production during the financial year and the difference so far as it can be estimated, becomes capital expenditure and augments the capital value of the field and therefore of the estate.

Maintenance.—The foregoing point involves the idea of capital appreciation. As a corollary, if maintenance operations in a field of crop-trees, such as weeding, sanitation, &c., are withheld, the valuation of the field of trees should be proportionately written down. This is quite distinct from depreciation which is a charge made in connection with the probable life of a thing on the assumption that its efficiency is reasonably maintained. The determination of the amounts which should constitute proper maintenance charges is one of the most important matters in estate accountancy. It is a problem which is largely technical and statistical and is best arrived at on a basis of man-hours.

Specimen Accounts.—The Field and other accounts appearing with this article will, if carefully studied, show the general principles and method of financial cost accounting in respect of tropical estates. The accounts given belong to the Balance Sheet and the financial accounts appearing on p. 75 of the May issue of this Journal. The present accounts are really the Working Account on p. 76 analysed or broken up on a costings basis. The three accounts presented here form part of in all twenty-nine accounts which constitute the Cost-Financial Ledger of the coconut estate under consideration. This estate is a small but very prolific one on the sea-coast and is served by coastal steamer, the produce being bought on the beach by an agent from the principal port. The twenty-nine accounts made out for this estate on the present cost-financial system comprise : Capital account, Private account, Bank account. Fields : A account, B account, C account, D account, E account, F account,

Coconut Field A Account.

[*The fact should be clearly appreciated that it is not the figures themselves but their entry and the methods and principles involved that are important in this and the following accounts. The figures (some of them merely rough estimates) were obtained on an estate with exceptionally good natural resources and facilities, and the credit balances shown are above the average.*]

To Valuation	$6,580	00	
Wages (for cutlassing)	65	00	
,, (for drainage)	100	00	
,, (for applying manure)	2	00	
,, (for picking nuts)	8	00	
,, (for gathering, &c.)	40	00	
,, (for husking)	60	00	
,, (for sanitation)	10	00	
,, (for supplying)	1	00	
,, (for transport to yard)	15	00	
Manure (for kainit)	20	00	
Cattle (for manure)	3	00	
Implements and Carts (for depreciation)	2	50	
Fibre and Shell (manure)	10	00	
Cattle (for transport)	10	00	
,, (for transport to yard)	5	00	
Taxes (Land)	12	50	
Establishment Charges	80	00	
	$7,024	00	

By Cattle (for grazing)	$	1	00
Valuation: Trees	6,475	00	
Drainage	75	00	
Manure (kainit)	15	00	
Coconuts Account (cost of production delivered at estate yard)	458	00	
	$7,024	00	

Area of Field A=25 acres. No. of nuts harvested 100,000. No. of trees per acre, 60. Cost per acre=$18·32. Cost per 1,000 nuts $4·58. (Note that $458÷100=cost per 1,000 nuts is also given by *cost per acre divided by number of thousand nuts per acre*; thus $18·32×0·25=$4.58. This may prove misleading economically and will be considered more closely in a future article.)

Coconuts Account.

To Valuation (nuts on hand)	$	50	00
Wages (for counting nuts from each field	10	00	
,, (for selecting)	40	00	
,, (for bagging, &c., and delivering of selects on beach)	53	00	
Establishment Charges	135	00	
Field A account (cost of nuts delivered)	458	00	
,, B ,, ,,	430	00	
,, C ,, ,,	440	00	
,, D ,, ,,	407	00	
,, E ,, ,,	421	00	
,, F ,, ,,	403	00	
,, G ,, ,,	464	00	
,, H ,, ,,	486	00	
Profit and Loss Account (*Cr.*)	6,085	00	
	$9,882	00	

By Bank (400,000 selects at $20 per 1,000 on the beach)	$8,000	00	
Copra Account	1,742	00	
Fibre	60	00	
Valuation (nuts on hand)	80	00	
	$9,882	00	

Omitting valuation, cost of bagging, &c. the selects, and one-half establishment charges, the remainder=cost of 800,000 nuts (for 8 fields of 25 acres) up to the completion of selection with the culls* ready for breaking for copra and the selects ready for bagging. Cost =$3,626.50=$4.53 per 1,000. Since selects and culls are in ratio of 1:1 and the selects have cost 35c. per 1,000 less to transport in and from the fields, cost per 1,000 selects is $4.705, cost per 1,000 culls is $4.355. Total $9.060 ÷ 2=$4.53.

(* Culls are husked nuts which pass through an iron ring 4 inches in diameter.)

Cost per 1,000 selects delivered on beach=$4.705+30.1 cents=$5.

Copra Account.

To Coconuts Account (for 400,000 culls at $4.355,	$1,742	00	
Wages (for breaking nuts)	260	00	
,, (for sun-drying)	88	00	
,, (for bagging, &c., and delivering on beach)	21	00	
Buildings (for depreciation)	20	00	
Establishment Charges	175	00	
Profit and Loss account (*Cr.*)	5,644	00	
	$7,950	00	

By Bank (for sale of copra at $125 per ton on the beach)	$7,900	00	
Cattle (for meal)	30	00	
Shell	20	00	
	$7,950	00	

No. of tons of copra made, 63·2. No. of culls to the ton, 6,330. Cost of making and delivering on beach a ton of copra from nuts after selection in yard $564÷63·2=$8·90. Total cost of a ton of copra delivered on beach $2,306÷63·2=$36.42.

G account, H account (all separate), Coconuts account, Copra account, Fibre and Shell account, Cattle (work) account, Cattle (stock) account, Labour account, Establishment charges account, Implements and Carts account, Buildings account Water Supply account, Horse and Buggy account, Sheep account, Taxes and Insurance account, Interest account, Mortgage account, Manure (artificial) account, Bags account, and General Profit and Loss account. The resulting Balance Sheet is the same as that on page 74 (May issue).

Valuation.—The valuation of Field A is on a cost basis with allowance for depreciation (*see* p. 91 of this Journal for June). It will be noticed that there has been appreciation as well as depreciation due to unexhausted expenditures (drainage and kainit). The valuation of the copra house, &c., appears under Buildings account, but it will be noticed that Copra is charged with the depreciation of the copra buildings, Buildings account being credited.

Labour Credited.—Accounts like Labour (Wages) Establishment Charges (Supervision), and Cattle (working), balance in this system, for their accounts are credited by those productive accounts that receive their services.

An Annual Statement.—It should be made clear that the accounts described are intended to be drawn up only once a year, namely at the end of the financial period which should fit in with the crop period. In the case of sugar-cane and annual crops special modifications of the system are necessary.

Survey and Inventory of Trees.—A scientific costing system presupposes the existence of a plan of each field or section, and an inventory of the trees. An inventory need only be made once if proper records are kept of losses and supplies. In Trinidad and in many other tropical colonies the areas of fields are not known nor in most cases is there an accurate enumeration of the trees especially in respect of their ages and productivity. Field surveys and inventories are essential and most practical planters will admit this even if only from the point of view of checking task work.

Value of the System.—The system put forward in this article gives a summarised and practically true statement of the working and financial position of an estate for any year. Absolute exactitude is impossible, for allocations can at the best be only approximately correct. But the system provides a truer picture of management and finance than do the systems of accounting in general use. A cost-financial statement would be immediately appreciated by Banks, Financiers and by Income Tax authorities, and its employment would tend to reduce book profits and therefore lessen income tax payments. But its great value lies in its uniformity, continuity and purpose in providing a local industry with accurate costs and standards for comparison and any one estate with a searching analysis of its technical management and financial administration.

(To be continued.)

MECHANICAL TILLAGE.

PROFESSOR J. SYDNEY DASH, B.S.A.

The main purpose of this article is to bring to the attention of agriculturists some of the more recent developments in connection with the use of agricultural machinery particularly with respect to tillage and cultivation of the soil in sugar production, though much of what has been achieved in this direction may ultimately find application in regard to many crops under tropical conditions.

At the outset a brief statement as to the meaning and objects of tillage may be permissible. Tillage refers to the operations to which the soil is subjected in the course of crop production. It has three principal objects: (1) modification of the structure (2) disposal of weeds and other material on the surface of the soil and the incorporation of manures and fertilizers (3) planting and sowing. The most important of these is perhaps the first, which affects retention and movement of moisture, aeration, heat absorption and retention, and through these the biological and chemical processes of the soil. The objects mentioned combine to eliminate competition from weeds and to bring about that physical condition most favourable to root development and crop growth, designated by the term "tilth." Weather is an important factor in tilth formation and good tilth implies optimum moisture conditions, besides desirable degrees of fineness, firmness and depth. Thus tillage is considerably influenced by weather conditions and for greatest efficiency must be carried out when the soil is neither too wet nor too dry.

It is in this latter connection particularly that mechanical tillage ought to play a very important part in tropical agriculture, for whereas much of the tillage for sugar-cane is still being done after crop and during the rainy season—if it is to be completed at all, with the adoption of machinery it can proceed during the drier months, thus lessening the risk of doing irreparable damage to clay soils. Much progress too as regards depth of tillage has been rendered possible by machines, and subsoiling which before was impossible on a large scale owing to the difficulties of traction and slowness of the operation can now be profitably performed. Apart too from greater efficiency of the operations, bringing with it increased crop yields, more can be accomplished and larger areas handled than with animal-drawn implements and hand labour. As a natural concomitant of all this is the possibility of reducing costs of production admitted to be the greatest need of agriculture at the present time.

Referring to agricultural output, the President of the United States is recently reported to have said "the farm population is not increasing, but the improved methods of tillage and inventions in farm machinery have all contributed to increase the per capita output." In respect to the labour population of many parts of the tropics, the first part of this statement is equally true, conditions

steadily becoming worse and worse notably in countries hitherto largely dependent on indentured labour; but even where plentiful, hand labour is far from being cheap and for many field operations extremely slow, tedious and inefficient. Unfortunately, the average planter is not mechanically minded. This is borne out by the casual attention often displayed to the use of implements at all, still less to their ordinary care and protection from weather. It is true that the advent of the motor car has somewhat improved matters in this direction, and implement manufacturers themselves have done much to foster and spread mechanical knowledge. Nevertheless, speaking generally, agricultural education in the tropics is sadly behind the times in matters of this kind, and what has so far been accomplished is largely the outcome of necessity on the part of companies striving in one way or another to increase output and reduce costs.

Turning now to the other side of the picture, it is refreshing to learn of the progress made in many places with mechanical tillage. A recent report from Hawaii gives a brief account of the history of developments there and mentions some of the more recent introductions. The oldest type of power-driven implement imported into the islands is the Fowler steam plough, introduced about 1881. Since then, this system has steadily increased in popularity until now about 90 per cent. of the ploughing is done by steam ploughs, mould-boarding being performed by tractors of which the Holt is one of the principal kinds in use; there are several light types used for cultivation and other light work. An outstanding implement recently devised in the territory is a planting machine, reported to be the most highly perfected cane planter built. It is tractor drawn and plants six acres per day.

It is now fairly well understood that on heavy soils such as those frequently met with in sugar regions, light instruments cannot satisfactorily perform the heavier operations of tillage. In this connection, a new implement which is attracting considerable attention is the "Killefer" subsoiler, of which there are about fifty in Hawaii. It is claimed that with this type of plough a greater depth of soil may be broken up, which is loosened in such a way as to allow it to weather before being worked up in the surface soil. There are several designs, of which perhaps the most effective in the destruction of plough pan is the so-called Killefer Chisel. A 60 H.P. tractor is required to pull a single standard Killefer 22 inches deep where difficult pan is encountered. The manufacturers state that they build the Killefer for most effective work rather than for light draft, recognizing that the implement owes its existence to the use for many years of light draft tools on soils.

Certain agriculturists from British Guiana interested in mechanical tillage recently visited the "Killefer" in its home in California and are highly satisfied with all they saw of its work; such an implement seems likely to prove suitable for breaking up heavy clays liable to bake and become like concrete under tropical conditions. As a matter of fact trials with this tool modified to meet the special conditions of British Guiana are reported as being very successful; a Holt caterpillar tractor provided with winch attachment supplies the power, the implement itself being cable towed. This arrangement along with the special wheels (5 feet diameter) fitted to the Killefer enables ditches to be easily crossed with the tool kept at a constant depth. We hope to hear more of this work in the near future.

In Porto Rico, several of the largest centrals have practised mechanical tillage for many years; both steam tackle and tractors of various kinds are in use. As to subsoiling, a prominent field superintendent there told the writer not long ago that by using a system of subsoil knives operated with steam ploughs he had increased yields by over 30 per cent. from this treatment alone. Now comes a new invention known as the Storey plough, designed by Mr. N. C. Storey of Porto Rico. Although called a plough it is unlike any type with which one is usually familiar. Instead of share and mouldboard it is equipped with powerful revolving knives attached to rotary drums; these knives stir and pulverize the hardest soil, it is said, to a depth of from 8 to 24 inches, at the same time leaving a fine mulch on the surface. A furrowing plough is attached to the machine for making the furrows to receive the cuttings. It is motor driven and the power is applied direct, the wheels being used only to carry the machine over the ground. From 5 to 10 acres a day can be done with it, depending on the nature of the soil.

Trash and detritus disposal has always been a troublesome problem in implemental tillage. Very frequently it has been removed by burning, a practice now greatly discouraged in most sugar-growing countries on account of the loss of organic matter. The Howard Sugar Cane Trash Cutter and Plough combined, described some time ago in the "Louisiana Planter," as the invention of Mr. T. J. Howard who studied the problem of trash disposal in Mexico and Cuba, seems likely to attract attention. This device is reported to have a combination of adjustable knives and revolving cutters, and so constructed that it will cut all cane shucks and trash into very short lengths; a set of ploughs attached to the rear of the machine turns the cut material into the soil and cultivation can then proceed unhampered.

A few pertinent observations in Trinidad, where certain of the larger sugar concerns have adopted the Fowler system, may now be recorded. Quite recently a heavy disc harrow equipped with large 30 inch discs and capable of a total expansion of 16½ feet has been added to the equipment on one place. This is considered more efficient than the drag type with spike teeth, and moreover, it has been found that by passing this implement first over the ground before actually ploughing, the trash and other waste is cut up into lengths

which are effectively covered by the ploughs. On the estate in question with two sets of ploughs and one of harrows operated by Fowler engines 700-800 acres can be disposed of during a period of about four months (February to May) when the weather conditions permit of their use. This is an enormous advantage when it is borne in mind the conditions under which heavy field work has to be performed in the average Trinidad wet season. As regards costs, these are given as approximately $3.00 per acre for ploughing and harrowing inclusive of labour, fuel, repairs, &c. The animal-drawn implements cost about the same for similar operations, while the former combine greater efficiency with greater speed. Increased yields are reported all round from fields tilled mechanically.

In conclusion, it may be remarked that a point frequently brought up in connection with mechanical tillage is the loss of time occasioned by breakdowns, delays in starting, travelling and the like. Inquiries into this question in Hawaii have shown that the losses may amount to as much as 20 per cent. of the total working time. By instituting a daily report system to check up the work of each individual driver better supervision of the machines has resulted and much of this trouble overcome. Undoubtedly, where skilled labour is difficult to obtain, this factor has always operated seriously against the adoption of agricultural machinery. As already pointed out, however, the advent of the cheap motor car has done much to stimulate mechanical skill in places where hardly any existed. In any case, where ordinary animal-drawn implements are used (and it is obvious that especially on small estates they can never be entirely given up) but few agriculturists give adequate attention even to such elementary matters as the proper setting of their ploughs, the proper working of the various adjustments, and the correct hitching of the animals. There is evidently much to be done in this direction before the maximum efficiency can be obtained from the implements already in use on the average estate.

CURRENCY AND AGRICULTURE.—The Aryan (Nordic) invaders of "Greece" (1000 B.C.) and Southern India (5000 B.C.) used to barter in terms of oxen. The Greeks and Romans used coins (first made by the King of Lydia 700 B.C.); but the Latin word for money *pecunia* is derived from *pecus* (=cattle). The Kaffirs and the natives of Zanzibar still use cattle for bartering, while the natives of Fiji, in some of the islands employ whale's teeth. The Aztecs of Mexico were employing cacao beans as money when Cortez arrived in the sixteenth century, and a century later the colonists of New England found it convenient to barter in terms of tobacco. The ancient Israelites and Phoenicians, who were the earliest and in some respects the greatest traders the world has ever known, invented metal weights as currency. That was long before the building of Carthage (800 B.C.).

ENGINEERING.

A NEW STEAM GENERATOR.—A complete revolution in steam practice appears possible from the results recently obtained in trials with the Benson 3,200 lb. pressure steam generator. In this apparatus, water is converted into steam at its "critical" temperature, 706° F. (375° C.). The critical temperature of a gas, as is well known to students of physics, is that temperature at which a liquid changes into vapour *without alteration in volume.* The change thus takes place without ebullition or "boiling," since there is no sudden conversion of small particles of water into comparatively large bubbles of steam; liquid passes into vapour quietly with no show of explosive violence. At the same time, no "latent heat" is required to effect the change of state at the critical temperature because no work has to be done to bring about an increase in volume. The chief practical value of the Benson method lies in its great economy of fuel. By its employment, power can be generated from coal at an efficiency of 28 to 30 per cent. as compared with 17 to 18 per cent. for the most modern high pressure steam generator operating at 350 lb. pressure and at 700° F. According to an article in the *Journal of the Society of Chemical Industry* (March 7, 1924), a Benson steam generator recently installed at Rugby, England consists of a generator coil made of $\frac{3}{4}$-inch steel tube, $\frac{1}{4}$ inch thick. The coil is 8 feet tall, and encircles a vertical cylinder of fire brick. The coil is surrounded by a casing of refractory material, which, in turn, is enclosed by another coil acting as a superheater. Water is forced at a pressure of 3,200 lb. into the base of the inner coil. The whole arrangement is heated from the bottom by means of an oil-blast flame supplied with hot air, but pulverized fuel or gas are stated to serve equally well. The water as it travels upwards through the coil is gradually heated to a temperature of 706° F. by which time it has traversed about nine-tenths of the height of the coil. At this point, the whole mass of the water is bodily and quietly converted into steam. The steam emerges through a reducing valve, where its temperature falls from 720° F. to 620° F., into the superheated coil, being finally discharged from the latter at 1,500 lb. pressure, and 850° F. temperature. The high pressure steam is employed to drive a turbine, exhausting at 200 lb. pressure into an ordinary condensing turbine. The exhaust steam from this may finally be employed for heating purposes. This Benson generator offers possibilities of employment in tropical chemical technology, where economy of fuel is frequently a problem of primary importance. Further details of its construction and capabilities will be awaited with great interest.

There is such a thing as human culture, as well as agri-culture; neither should be neglected in rural education.

ENTOMOLOGY.

ECONOMIC VALUE OF THE LACE-WING FLIES.—The Neuroptera or Lace-wing flies are known to be of value to the agriculturist from their habits and those of their larva of feeding upon various noxious insects, such, for instance, as aphids, scale insects, mealy bugs, red spider, &c. In a paper by C. L. Withycombe M.SC., PH.D., of the Imperial College of Tropical Agriculture, in *The Annals of Applied Biology* (Vol. XI April, 1924), details are given of a large number of species of Neuroptera studied, and their individual preferences in food are noted. Frequently one species of lace-wing favours a particular species of aphid as food, and the lace-wing may constitute a very important check upon the pest. Such information as this is of great value should a pest be introduced accidentally into a country where its natural enemies do not occur. This has often happened in the past, the introduction of the Gipsy moth, which is controlled naturally in Europe, into the United States where it became a serious pest; of the mongoose from India, where it is a natural member of the fauna, to the West Indies where it became a great nuisance until the balance was restored. If we can discover the natural factors controlling any insect in one country and can then reproduce the same conditions in a country where the insect has been artificially introduced and has become a pest it is possible to control the pest. This has been successfully achieved in Hawaii with sugar-cane leaf-hoppers by introducing parasites. Never yet, however, has it been possible of course to reproduce *all* the conditions prejudicial to the pest. Apart from information as to the specificity of certain Neuroptera for the control of certain aphids, &c., recommendations and cautions are given for the introduction of lace-wings where necessary to other countries. Attention is particularly drawn to the potentialities of the Coniopterygidae, a family of small Neuropterous insects resembling white-flies. These might well be introduced where it is desirable to control small aphids, scales, red spider, &c., upon crops or in greenhouses where it is impossible or undesirable to spray. Biological control of pests when practicable is always more lasting in effect than spraying and the like, and while it has limitations much can be done under indicated conditions.

MOSQUITO CONTROL.—One of the most effective methods of killing mosquito larvae in pools of water which cannot otherwise be dealt with is by the practice of oiling. A small amount of kerosene or other mineral oil is poured upon the surface of the water and this forms a film which suffocates the mosquito larvae by preventing them from obtaining access to the air, since larvae are not able to push their breathing apparatus through an air film. This method has its drawbacks. Firstly, pools require oiling once or twice a week to be kept quite free of mosquitoes. Secondly, the presence of vegetation tends to prevent the spreading of the oil film into every nook. By the addition of castor oil matters are improved some what. A promising line of investigation in this direction was started by Caballero in 1919. He found that when plants of *Chara* were growing in pools, no mosquito larvae were present. This led him to experiment with *Chara* and he discovered that the water in which these plants had grown was definitely toxic to mosquito larvae. Larvae placed in an aquarium where *Chara* also was growing died in a day or so. Some other entomologists have confirmed Caballero's work with various species of *Chara* and this method of control seems to offer possibilities.

COLLEGE NEWS.

The Governing Body have appointed Dr. H. M. Leake, M.A., SC.D. (Cantab.), F.L.S., late Director of Agriculture, United Provinces, India, and late Principal of the Cawnpore Agricultural College, to succeed Sir Francis Watts, K.C.M.G., as Principal. Dr. Leake's researches in connection with the genetics of cotton have constituted important contributions to Agricultural Science, and Dr. Leake is also the author of a work on the economics of Indian Agriculture, and of a valuable report on the cotton position in Egypt.

Mr. O.F. Boyd, B.A., newly appointed Professor of Sugar Technology, arrived in Trinidad on June 21, to take up his duties at the College.

Professor Dunlop gave an address before the Agricultural Society of Trinidad at the Council Chamber, Port-of-Spain, on June 12, the subject being "Points in connection with the Economics of Cacao."

At the meeting of the Savana Grande District Agricultural Society held in Princes Town on June 10, Professor Dash delivered a lecture on the subject of weed control, which was much appreciated by those present who were mainly composed of small farmers. This is important in its bearing on the College agricultural extension work which has in view the establishment of personal contact with all classes of producers.

Communications have been received by the Principal from the Colonial Office in regard to the special training of officers of the Nigerian Department of Agriculture at the College as a continuous system in the near future.

The results of the tennis match between the Post-graduate and the Diploma ssudents recently were as follows:—*Singles*—A. B. Killick lost to H. C. Vilain; D. S. Haig lost to S. Evelyn; J. C. Hopkins lost to H. C. Vilain; G. W. Nye beat S. Evelyn. *Doubles*—Killick and Parga beat Wiles and McKinstry and lost to Vilain and Evelyn; Haig and Nye beat Wiles and McKinstry and beat Vilain and Evelyn. The match resulted in a draw—4 matches all—9 sets all.

On the occasion of his retirement from the Principalship, Sir Francis Watts was presented by the Post-Graduate and Diploma students with a silver cigar-box and expressions of their goodwill and esteem.

TREND OF THE MARKETS.

[*The notes below are based principally upon running charts of the prices of the basic grades and upon general statistical information gleaned from contemporary publications and cablegrams and are intended to be a record of movements. An attempt is made, where possible, to indicate the market outlook at the time of going to press, but no responsibility for the accuracy and subsequent truth of such observations is assumed. Unless otherwise stated the prices quoted are spot, London.*]

SUGAR.—Since the beginning of May there was a continuation of the fall in level which reached the lowest point at the beginning of June. During June there was a tendency to rise. Cubans quoted $5.30 New York, duty paid, June 20.

COTTON.—During the period April-June cotton prices showed two peaks, the first at April 12, and the second at May 29. Current prices fluctuate around 17·1*d.* per lb. (Fully Middling, Liverpool.) The first arrivals from Carriacou at Liverpool realised at 17¾*d.* per lb. (May 21).

CACAO.—During May both Trinidad and Accras showed a declining tendency the former reaching 52*s.* 6*d.* per cwt. on May 21 and the latter 28*s.* per cwt. at the same date.

COFFEE.—Brazilian Santos declined from inordinately high levels during May but even then stood at 88*s.* per cwt.

TEA.—The Indian average showed a firmer tendency at the end of May and beginning of June reaching 18*d.* per lb.

SISAL.—The price of prime Sisal continued the steady advance which began last November and reached the high level of £48 per ton on May 21. Price last November £35 per ton.

RUBBER.—The market weakened during May 10½*d.* being reported for May 28. There has been a steady downward trend since last September.

RICE.—Burmese continues steady in the neighbourhood of £16 a ton.

COPRA.—After the sudden fall in March the value of prime copra has fluctuated around £29 5*s.* per ton.

VEGETABLE OILS.—Position shows an improvement. Prices for all grades of palm oils advanced towards the end of May. Lagos 37*s.* The demand for Coconut was dull. Castor prices have jumped for all grades.

CITRUS PRODUCTS.—The London market for raw has been quiet owing to the unfavourable weather. For fine quality 2*s.* 9*d.* is asked. Concentrated unchanged, without business passing (May 21). Lime Oil, handpressed is quoted 8*s.* 6*d.* to 9*s.* being again dearer. Distilled 5*s.* per lb.

RUM.—Some enquiry has been experienced for export descriptions of Jamaica, fine quality being worth about 8*s.* 6*d.* per gallon. New Rums are rather firmer.

UNITED KINGDOM CUSTOMS TARIFF.

[*The following table shows the duties chargeable under Budget resolutions of April 29th, 1924, for the articles mentioned.*]

ARTICLES.		Rates of Duty.	
		Full.	*Preferential.*
		s. d.	
Cocoa :—	the cwt.	14 0	
Husks and shells	the cwt.	2 0	
Cocoa Butter	the lb.	0 1½	
Coffee :—			
Not Kiln-dried, Roasted or Ground	the cwt.	14 0	
Kiln-dried, Roasted or Ground	the lb.	0 2	Five-sixths of full rate.
Coffee and Chicory, Roasted and Ground, mixed	the lb.	0 2	
Glucose :—			
Solid	the cwt.	7 5	
Liquid	the cwt.	5 4	
Molosses and invert sugar, &c. :—			
If containing 70 per cent., &c.	the cwt.	7 5	
less than 70 per cent. but more than 50 per cent.	the cwt.	5 4	
not more than 50 per cent., &c.	the cwt.	2 7	
Saccharin, &c.	the oz.	3 9	

Rates of Duty.

	Full	*British Preference.*	*Preferential.*
Sugar cwt.	s. d.	s. d.	s. d
76 ,,	5 7	11·1	4 7·9
76-77* ,,	5 9·4	11·5	4 9·9
77-78 ,,	5 11·6	11·9	4 11·7
78-79 ,,	6 1·9	1 0·3	5 1·6
79-80 ,,	6 4·4	1 0·7	5 3·7
80-81 ,,	6 6·4	1 1·1	5 5·3
81-82 ,,	6 8·6	1 1·4	5 7·2
82-83 ,,	6 10·8	1 1·8	5 9
83-84 ,,	7 1·4	1 2·2	5 11·2
84-85 ,,	7 3·9	1 2·6	6 1·3
85-86 ,,	7 6·4	1 3·1	6 3·3
86-87 ,,	7 8·9	1 3·5	6 5·4
87-88 ,,	7 11·7	1 3·9	6 7·8
88-89 ,,	8 2·5	1 4·4	6 10·1
89-90 ,,	8 5·9	1 5	7 0·9
90-91 ,,	8 9·2	1 5·5	7 3·7
91-92 ,,	9 0·6	1 6·1	7 6·5
92-93 ,,	9 4·0	1 6·7	7 9·3
93-94 ,,	9 7·3	1 7·2	8 0·1
94-95 ,,	9 10·7	1 7·8	8 2·9
95-96 ,,	10 2·0	1 8·3	8 5·7
96-97 ,,	10 5·4	1 8·9	8 8·5
97-98 ,,	10 8·8	1 9·5	8 11·3
98 ,,	11 8	1 11·3	9 8·7
Tea the lb.	0 4	—	—

* Exceeding 76° but not exceeding 77°.